

What is claimed is:

1. An optical mode transformer comprising:
  - an n-doped InP substrate;
  - 5 an n-doped InP buffer disposed on the n-doped InP substrate;
  - a buried ridge stripe structure grown on the n-doped InP buffer, the buried ridge stripe structure having a passive waveguide of an InGaAsP composition;
  - a p-doped InP re-growth layer for burying the passive waveguide onto the n-doped InP buffer; and
  - 10 a buffer compensator disposed within the n-doped InP buffer, the buffer compensator having Ga and As atoms to compensate for the carrier-induced change in refractive index of the n-doped InP buffer layer for resulting in a compensated n-doped InP buffer layer such that the compensated n-doped InP buffer layer has a reduced index difference between the p-doped InP re-growth layer and the compensated n-doped InP buffer layer.
- 15 2. The optical mode transformer of claim 1 wherein the buffer compensator comprises a series of thin InGaAsP layers inserted into the n-doped InP buffer.
- 20 3. The optical mode transformer of claim 1 wherein the buffer compensator comprises a series of thin InGaAsP layers disposed on top of the n-doped InP buffer.
4. The optical mode transformer of claim 1 wherein the buffer compensator  
25 comprises at least one InGaAsP layer disposed within the n-doped InP buffer.
5. The optical mode transformer of claim 1 wherein the buffer compensator comprises at least one InGaAsP layer disposed on top of the n-doped InP buffer.

6. A method for mode transforming between a smaller mode of an In-P optical device and a larger mode of an optical fiber, the method comprising the steps of:
- providing a Silicon motherboard for supporting the In-P optical device and the optical fiber;
  - providing an n-doped InP substrate;
  - growing an n-doped InP buffer on the n-doped InP substrate;
  - growing a buried ridge stripe structure on the n-doped InP buffer, the buried ridge stripe structure having a passive waveguide of an InGaAsP composition for confining a guided optical wave from the In-P optical device to the optical fiber for forming an optical mode transformer;
  - growing a p-doped InP re-growth layer for burying the passive waveguide onto the n-doped InP buffer;
  - disposing within the n-doped InP buffer Ga and As atoms to compensate for the carrier-induced change in refractive index of the n-doped InP buffer layer for resulting in a compensated n-doped InP buffer layer such that the compensated n-doped InP buffer layer has a reduced index difference between the p-doped InP re-growth layer and the compensated n-doped InP buffer layer to form a mode transformer; and
  - disposing the mode transformer grown on the n-doped InP substrate onto the Silicon motherboard.
7. The method of claim 6 wherein the step of disposing within the n-doped InP buffer Ga and As atoms includes inserting at least one InGaAsP layer into the n-doped InP buffer.
8. An optical mode transformer assembly for mode transforming between a smaller mode of an In-P optical device and a larger mode of an optical fiber, the optical mode transformer assembly comprising:
- a Silicon motherboard for supporting the In-P optical device and the optical fiber;
  - an n-doped InP substrate disposed on the Silicon motherboard;

a buried ridge stripe structure defined monolithically on the n-doped InP substrate, the buried ridge stripe structure having a passive waveguide of an InGaAsP composition for confining a guided optical wave from the In-P optical device to the optical fiber;

5 a p-doped InP re-growth layer disposed on top of the buried ridge stripe structure for burying the passive waveguide; and

a compensated n-doped buffer disposed between the n-doped InP substrate and the buried ridge stripe structure, the compensated n-doped buffer having a sufficient concentration of Ga and As atoms such that the compensated n-doped buffer layer has a reduced index difference between the p-doped InP re-growth layer and the compensated n-doped buffer layer.

9. An optical mode transformer for mode transforming between a smaller mode of an optical device having a first composition and a larger mode of an optical fiber, the optical mode transformer comprising:

15 a Silicon motherboard for supporting the optical device and the optical fiber;

a substrate having the first composition doped with a first dopant, the substrate disposed on the Silicon motherboard;

20 a waveguide defined monolithically on the substrate, the waveguide having a second composition co-existing with the first composition for confining a guided optical wave from the optical device to the optical fiber;

a re-growth layer having the first composition doped with a second dopant, the re-growth layer disposed on top of the waveguide; and

25 a buffer disposed between the substrate and the waveguide, the buffer doped with the first dopant and having a lower concentration of the second composition than the first composition for compensating the carrier-induced change in refractive index of the re-growth layer such that the buffer layer has a reduced index difference between the re-growth layer and the buffer layer.

10. The optical mode transformer of claim 9, wherein the first composition comprises InP.

11. The optical mode transformer of claim 9, wherein the second composition comprises GaAs.

12. The optical mode transformer of claim 9, wherein the second composition comprises a III-V compound.

13. The optical mode transformer of claim 9, wherein the first dopant provides for n-doping.

14. The optical mode transformer of claim 9, wherein the second dopant provides for p-doping.

15. The optical mode transformer of claim 9, wherein the first dopant and the second dopant are of opposite polarity.

16. The optical mode transformer of claim 9, wherein the buffer comprises a thin series of layers of the second composition disposed on a bulk deposition of the first composition.

17. The optical mode transformer of claim 9, wherein the buffer comprises an alloy having a lower concentration of Ga and As atoms than In and P atoms.

18. The optical mode transformer of claim 9, wherein the buffer has a lower concentration of Ga and As atoms than In and P atoms.

19. A mode transformer comprising:  
a passive waveguide having a first composition co-existing with a second composition to provide a guided optical wave;

a p-doped re-growth layer having the first composition disposed on top of the passive waveguide; and  
a compensated n-doped buffer disposed underneath the passive waveguide, the compensated n-doped buffer having the first composition and a sufficient concentration of a third composition such that the compensated n-doped buffer layer has a reduced index difference between the p-doped re-growth layer and the compensated n-doped buffer layer to compensate the index difference between the p-doped re-growth layer and an un-compensated n-doped buffer in order to preserve the symmetry of the guided optical wave.

20. The mode transformer of claim 19 wherein the first composition has a first refractive index and the third composition has a second refractive index that is greater than the first refractive index.

21. The mode transformer of claim 20 wherein the third composition is the same as the first composition.

22. The mode transformer of claim 20 further comprising a substrate for epitaxially growing the buffer layer.

23. The mode transformer of claim 22 wherein the substrate comprises a III-V compound.

24. The mode transformer of claim 23 wherein the substrate has the first composition comprising at least one of the group III elements of In, Ga, or Al, compounded with at least one of the group V elements of As, P, N, or Sb.

25. The mode transformer of claim 24 wherein the compensated n-doped buffer is deposited by epitaxy on the substrate.

26. The mode transformer of claim 24 wherein the passive waveguide having the first composition of InP co-existing with the second composition of GaAs to provide a quaternary passive waveguide layer of InGaAsP, serving as a core, having a third refractive index.

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27. The mode transformer of claim 26 wherein the p-doped re-growth layer having the first composition of InP and the first refractive index, wherein the first refractive index of the p-doped re-growth layer is lower than the third refractive index of the quaternary passive waveguide layer to act as cladding for the core of the quaternary passive waveguide layer to confine light within the quaternary passive waveguide layer.

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28. The mode transformer of claim 23 wherein the substrate comprises the first composition of InP.

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29. The mode transformer of claim 23 wherein the substrate comprises the first composition of GaAs.

30. The mode transformer of claim 23 wherein the substrate comprises the first composition of InGaAs.